NOAA Chemical Modeling Workshop

Chemical Modeling Requirements
for
Weather Forecasting

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NOAA environmental Modeling Program

Overview

- Current NWS Operational Modeling
- Vision for Global Modeling
- National Unified Operational Prediction Capability
- Moving toward a common model architecuture
- Operational Technology Requirements

NOAA's Operational Model Production Suite

Ensemble
NAEFS

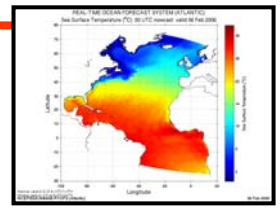
Global Data Assimilation
* 1.7B Obs/Day
* Satellites (99.99%)

Global
GFS

Climate
CFS
MOM3

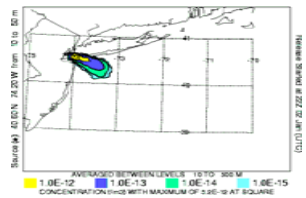
Hurricane/GFDL
Hurricane WRF

HYCOM
Ocean



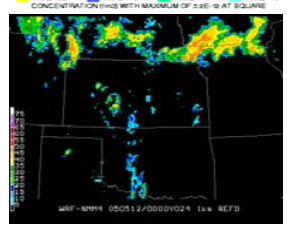
SREF
WRF-NMM
WRF-ARW
ETA
RSM

Dispersion

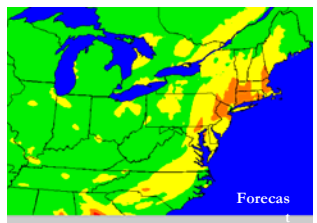


N D A S
Regional
NAM – WRF
NMM

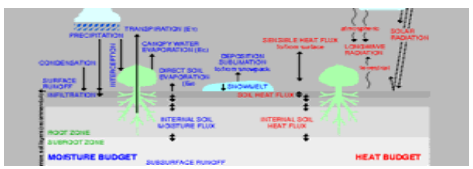
Sev Wx
WRF-NMM
WRF-ARW



Air Quality

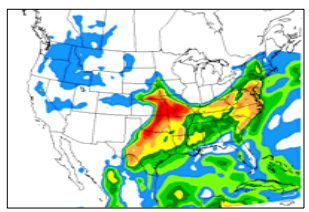


NOAH Land Surface Model



L D A S

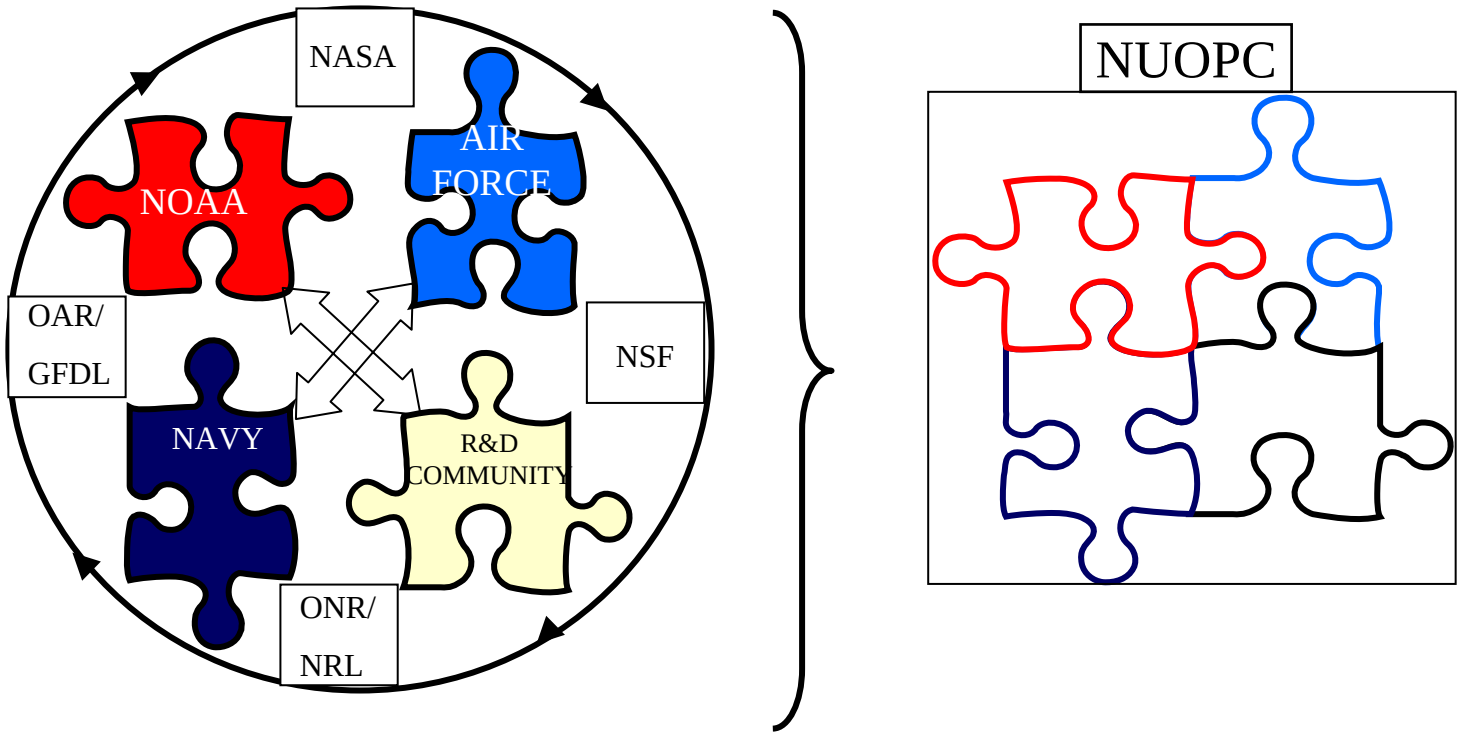
Rapid Update Cycle



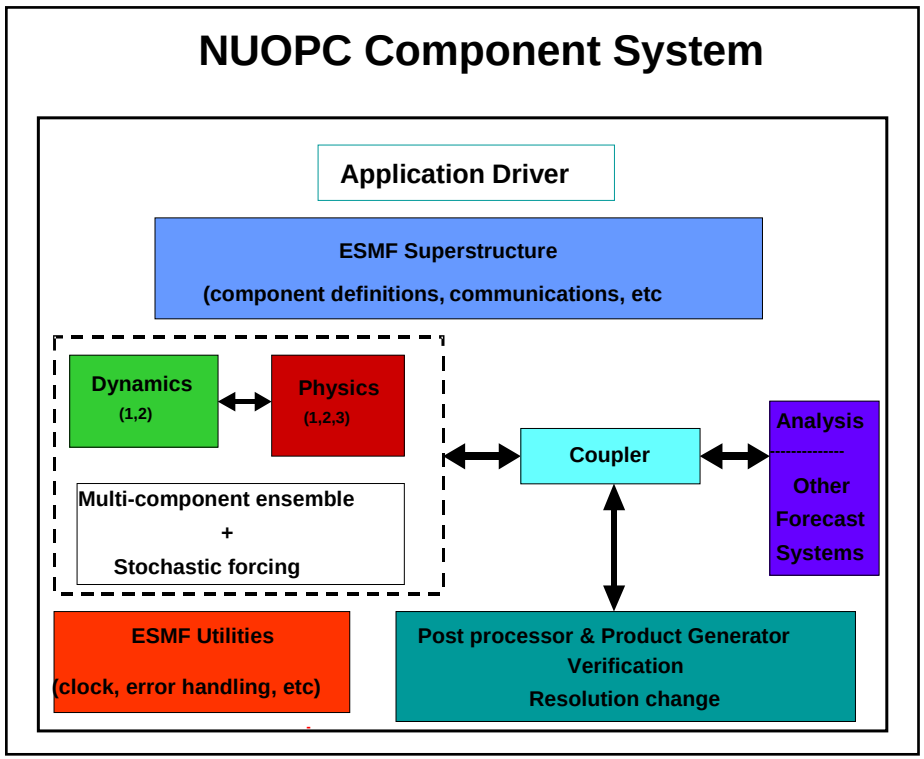
US National Global Modeling Vision (2015)

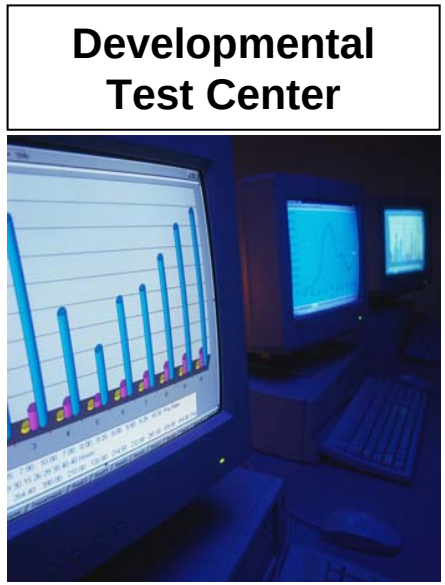
- A National System with a Tri-Agency (Federal) commitment to address common requirements
- Multi-component system with interoperable components built upon common standards and a framework such as the ESMF
- Managed ensemble diversity
  - significantly improve forecast accuracy
  - quantify, bound and reduce forecast uncertainty
- Joint ensemble
  - to produce most probable forecast e.g.high impact weather
  - Mission Specific ensemble products
    - Drive high-resolution regional/local predictions
    - Drive other down stream models
- Establish a national global NWP research agenda to accelerate development and transition

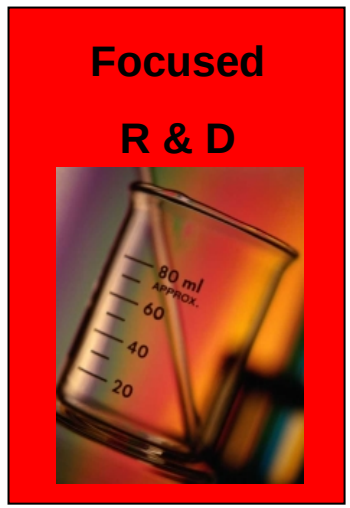
The NUOPC Goal:
A National Cooperative Effort



Vision: A National Global Modeling System



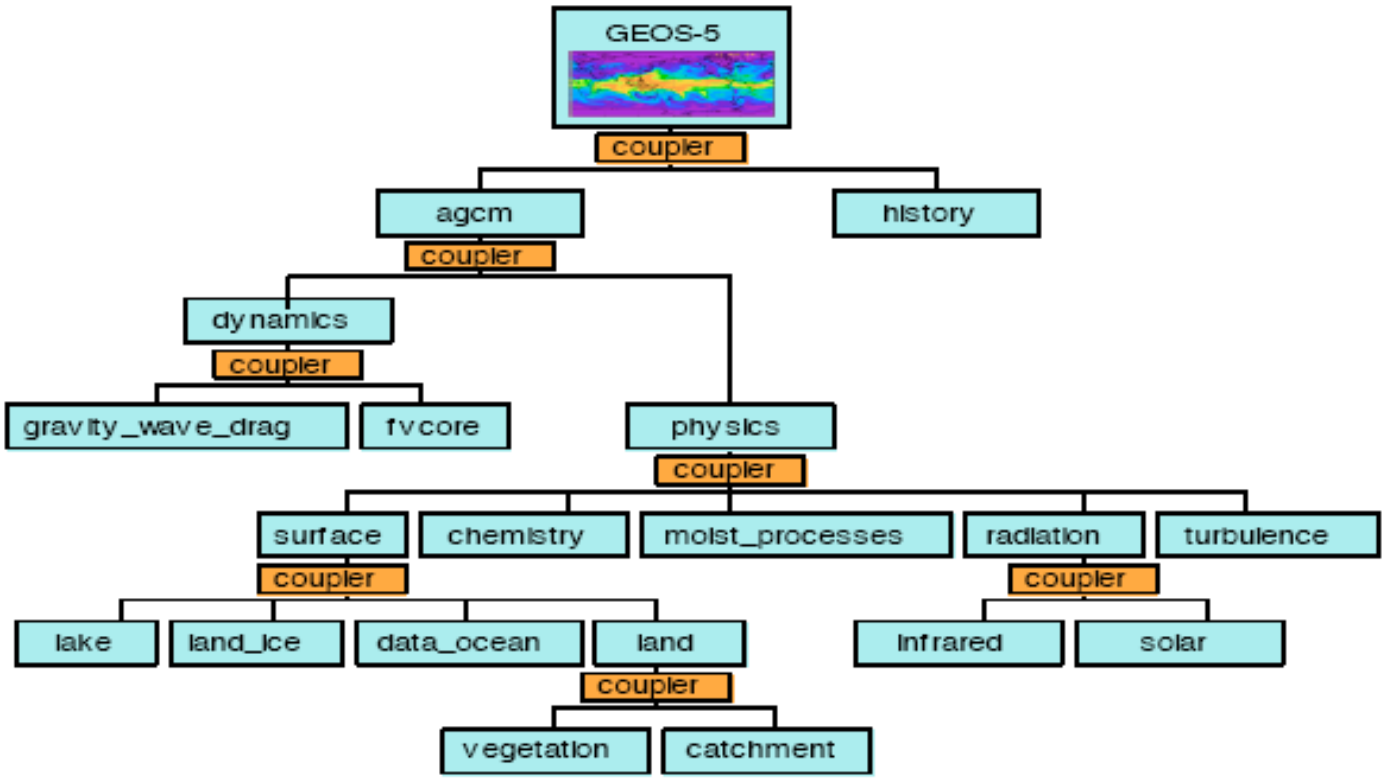




NUOPC DEFINED - 2015

- NUOPC is an integration of ongoing efforts coordinated by a Tri-agency management organization leading to a unified global modeling system with:
  - Common infrastructure, coding standards, metrics, transition processes – to the degree required to share technology and eliminate unnecessary duplication
  - Common development and implementation of ESMF
  - Cooperation and coordination at the technology level
  - Common operational global ensemble and post processing by design
  - Coordinated research needs representing National global modeling research requirements
  - Developmental test support and focused research seed money to accelerate transition of critical technology
- NUOPC is not:
  - An R&D or acquisition program
  - A unified management system for operations or acquisition
  - A unification of agency missions

ESMF GEOS-5



Structure of the GEOS-5 atmospheric general circulation model.

Chemical Modeling Requirements Overview

- **Improved *Weather* Forecast Performance**
  - Global and mesoscale weather analyses and forecast guidance
  - Short-term climate analyses and forecast guidance
  - Regional and global ocean analyses and forecast guidance
  - Ensembles

- **Runtime Requirements**
  - Next-generation models and enhancements
  - Improved run-time model performance
  - Ensembles

- **Data Assimilation and Analysis**
  - Forward Models for Chemical Constituents
  - Analysis uncertainty

- **Model Architecture and Infrastructure**

Chemical Modeling Requirements

Improved Weather Forecasts

- **Aerosols**
  - **Visibility for aviation and military applications**
  - **Improved Radiation Budget**
  - **Regional Model lateral boundary conditions**
  - **Global dust transport**
  - **Climatologies for seasonal forecasting**
- **Predictive Ozone at all levels**
- **Impact of chemistry on overall forecast performance**

Chemical Modeling Requirements Data Assimilation and Analysis

- Improved Radiance assimilation for Weather and Chemistry
  - Forward Models for new instruments (GOES, NPOESS, etc.)
  - Species differentiation
  - Vertical distribution
- Surface Observations from space
  - Reflectance
  - Emissions
- Analysis uncertainty

Chemical Modeling Requirments
Run-time Requirements

- Reduced Chemistry formulations
  - In-line computation for weather modeling
  - Multiple formulations to capture uncertainty
    - In initial conditions
    - Multi-model formulations for diversity(?)
- Loosely-coupled/one way coupled/Off-line
  - Air quality Forecast
  - Aerosol Species concentration and transport
- Global Chemical Modeling may drive need for additional computing
  - Must compete with other Mission requirements for available R&D and Operational computational Resources
  - Hazardous chemistry can drive need for ***additional*** resources

Chemical Modeling Requirements Common Model Architecture

- Standards for chemistry module Integration
- Standards for chemical model coupling
- NOAA standards must be integral to a national modeling standard
- Standardized transition protocols within NOAA
- Transition protocols aligned with those of other Federal Agencies

Summary

- Global chemical specie analysis and prediction needed
  - To improve weather and seasonal forecasts
  - To provide boundary conditions for regional models
- Significant Additional Computational Resource may be needed
- Common Model Architecture should include chemistry
  - Leverage the broader community
  - Enable and accelerate transition to operations
- Significant Research and Development resources will be required